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ORIGINAL

TRANSMISSION, CROSSDRIVE, HYDROMECHANICAL HMPT 500-3ECB

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RECORD OF REVISIONS

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A	GDLS-XM-00001	i,1,2,4,11,12,13, 15,16,17, 19,20,25 26,34,37,43	6/10/98
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TRANSMISSION, CROSSDRIVE, HYDROMECHANICAL HMPT 500-3ECB

PREPARED BY: GENERAL DYNAMICS LAND SYSTEMS

CONTRACT NO: TACOM DAAE07-97-C-T158

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APPROVED BY — DATE

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MLITARY SPECIFICATION

TRANSMISSION, CROSSDRIVE, HYDROMECHANICAL HMPT500-3ECB:

This specification is approved for use by the US Army Tank-Automotive Command Department of the Army and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers a fully automatic, hydromechanical crossdrive transmission, hereinafter referred to by the term, transmission. This transmission is part of the Transmission Electronic Control System.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

GG-P-455	Plates and Foils Photographic (Photosensitive Anodized Aluminum).

MILITARY

MIL-PRF-2104	Lubricating Oil, Internal Combustion Engine.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Tank-Automotive Command, ATTN.: AMSTA-GDS, Warren, MI 48397-5000, by using the self-addressed Standardization Document Improvement Proposal DD Form 1426) appearing at the end of this document, or by letter.

AMSC N/A FSC 2520

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

MIL-PRF-21260	Lubricating Oil, Internal Combustion Engine, Preservative and Break-in.
MIL-PRF-46167	Lubricating Oil, Internal Combustion Engine Arctic.
A-A-50271	Plate Identification

STANDARDS

MILITARY

MIL-STD-129	Marking for Shipment and Storage.
MIL-STD-130	Identification and Marking of U.S. Military Property.
MIL-STD-461	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-2073/1	Standard Practice for Military Packaging
SAE-J1926/1	Connections for General Use and Fluid Power - Ports and Stud Ends with ISO 725 Threads and O-Ring Sealing - Part 1: Threaded Port with O-Ring Seal in Truncated Housing, Standard

(Unless otherwise indicated, copies of the federal and military specifications and standards are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4 Section D, Philadelphia, PA 19111-5094)

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

TACOM

SPECIFICATIONS

12446252	Electronics Assembly: Transmission Electronic Control System.
---	Fighting Vehicle Systems RAM-D Failure Definition and Scoring Criteria.
12446503	Interface Assembly for HMPT500-3ECB Product Specifications

DRAWINGS

12380484	500-3ECB Shipping Hardware
12446205	Cable Assembly
12446501	Electronic Assembly (EA)
12446504	Transmission, Interface Control Drawing
12446586	Interface Assembly (IA)
12446500	Transmission, Crossdrive, Hydromechanical HMPT500-3ECB

PUBLICATIONS

LO-9-2350-252-23	Lubrication Order for Fighting Vehicles.
TM-9-2350-284-20-1	Organizational Maintenance Manual for Fighting Vehicle, Infantry, M2 and Fighting Vehicle, M3 for the HMPT500-3EC Transmission 2.2.

(Copies of other Government documents, drawings, and publications required by the contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

(Non-Government publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.2 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article Unless otherwise specified (see 6.2), the contractor shall furnish transmissions which shall be subjected to first article inspection (see 4.4). First article samples, properly marked with identifying information, shall be representative of the unit to be furnished to the Government. All subsequent transmissions delivered to the Government shall conform to these samples in all of their pertinent physical and performance attributes.

3.2 Materials design and construction. The design and construction of the transmission shall be in accordance with Drawing 12446500 and all data assembled thereunder. The transmission has a 600 hp (horsepower) rating and is a fully automatic, steering transmission with infinitely variable propulsion ratio in both forward and reverse ranges. When installed in a vehicle it will allow the vehicle to be towed without special preparation. Included as part of the transmission are oil-cooled multiple disc service/park brakes, an input disconnect clutch, and a full power takeoff (PTO).

3.2.1 Lifting eyes. The transmission shall be provided with three lifting points to permit ease of handling.

3.2.2 Oil filter maintenance indicator. The transmission shall be provided with a go/no-go indicator located at or near the transmission oil filter to signal when a maintenance action is required.

3.2.3 Drain plugs. The transmission oil drain shall provide a boss in accordance with SAE-J1926/1 for a 1.00 inch outside diameter tube. A magnetic element shall be provided in the transmission sump cover.

3.2.4 Inserts. Inserts shall be used in the aluminum members for all interface internal threads as specified on Drawing 12446504.

3.2.5 Dipstick. The dipstick shall have an area representing the safe transmission oil level operating range, with one boundary marked ADD the other marked FULL. The dipstick shall be so graduated or marked as to indicate the amount of oil to be added when the add limit has been reached. Provisions shall be made for the entry of a 3/8 inch outside diameter plastic tube into the oil sump to permit collection of an oil sample for analysis.

3.2.6 Weight. The transmission shall not exceed 1975 pounds (LB) dry.

3.2.7 Characteristics.

3.2.7.1 Interface. The transmission interface dimensions and features shall be in accordance with Drawing 12446504.

3.2.7.2 Installation control. The transmission envelope and access clearance dimensions together with the fittings and control linkage attachments required for installation, maintenance and co-functioning of the transmission to be installed shall be in accordance with Drawing 12446504.

3.2.8 Interchangeability. Each transmission shall be physically and functionally interchangeable with any other transmission designed, constructed, and accepted in accordance with this specification without selection.

3.3 Performance The transmission shall be operated as specified herein using lubricating oil conforming to seasonal requirements of MIL-PRF-2104 and MIL-PRF-46167 in accordance with the following ambient temperature conditions:

a. Grade 30 for an ambient range of +20 to +125 degrees Fahrenheit (°F).

b. 15W-40 for an ambient range of +5 to +125°F.

c. Grade 0W - 20 (arctic grade oil) for an ambient range of -70 to +40°F.

Unless otherwise specified, the oil temperature at the transmission inlet from the external oil cooler, when operating for the test sequences specified herein, shall be maintained at 190 ± 5°F.

3.3.1 Oil leakage When the transmission is operated for the test sequences specified herein, it shall show no evidence of a leak. A seep is permissible, but shall be recorded (see 6.5.2).

3.3.2 Transmission powers

3.3.2.1 Input power.

3.3.2.1.1 Mechanical power. The transmission shall be capable of accepting input power from a nominal 600 hp or 500 hp engine as shown on figures 1 and 2 respectively in accordance with the transmission command schedule shown on figures 3 and 4 respectively.

3.3.2.1.2 Electrical power. The transmission shall be capable of operation with control input power as specified by 12446252 connected through interface cable 12446205 or equivalent.

3.3.2.2 Output power. The transmission rated output speeds and torques shall be as specified in Table I.

3.3.3 Output torques for constant loads. The transmission shall operate with either 600 hp or 500 hp input conditions while demonstrating output speeds and corresponding output torques specified in Table II. The use of either 600 hp or 500 hp input conditions shall be as specified by the acquisition document (see 6.2). Steering shall be adjusted to balance output speeds of each side to within 25 rpm.

3.3.4 Durability. Unless otherwise specified by the acquisition document (see 6.2), the transmission shall be operated for the duration specified in Table III for the appropriate test sample. The use of either 600 hp or 500 hp input conditions shall be as specified by the acquisition document. Durability performance and durability component life shall be as follows:

a. Durability performance: Prior to initiation and upon completion of durability testing, the transmission shall conform to the performance requirements specified in 3.3 with the following exceptions. Upon completion of durability testing, the demonstrated performance shall meet the heat rejection requirements specified in 3.3.11 for an applied 5330 ±50 ft-LB load to the output shafts (2640 ft-LB minimum per side). This requirement shall be demonstrated only after the transmission has been drained and refilled with new oil.

FIGURE 1. Engine performance (600 horsepower).

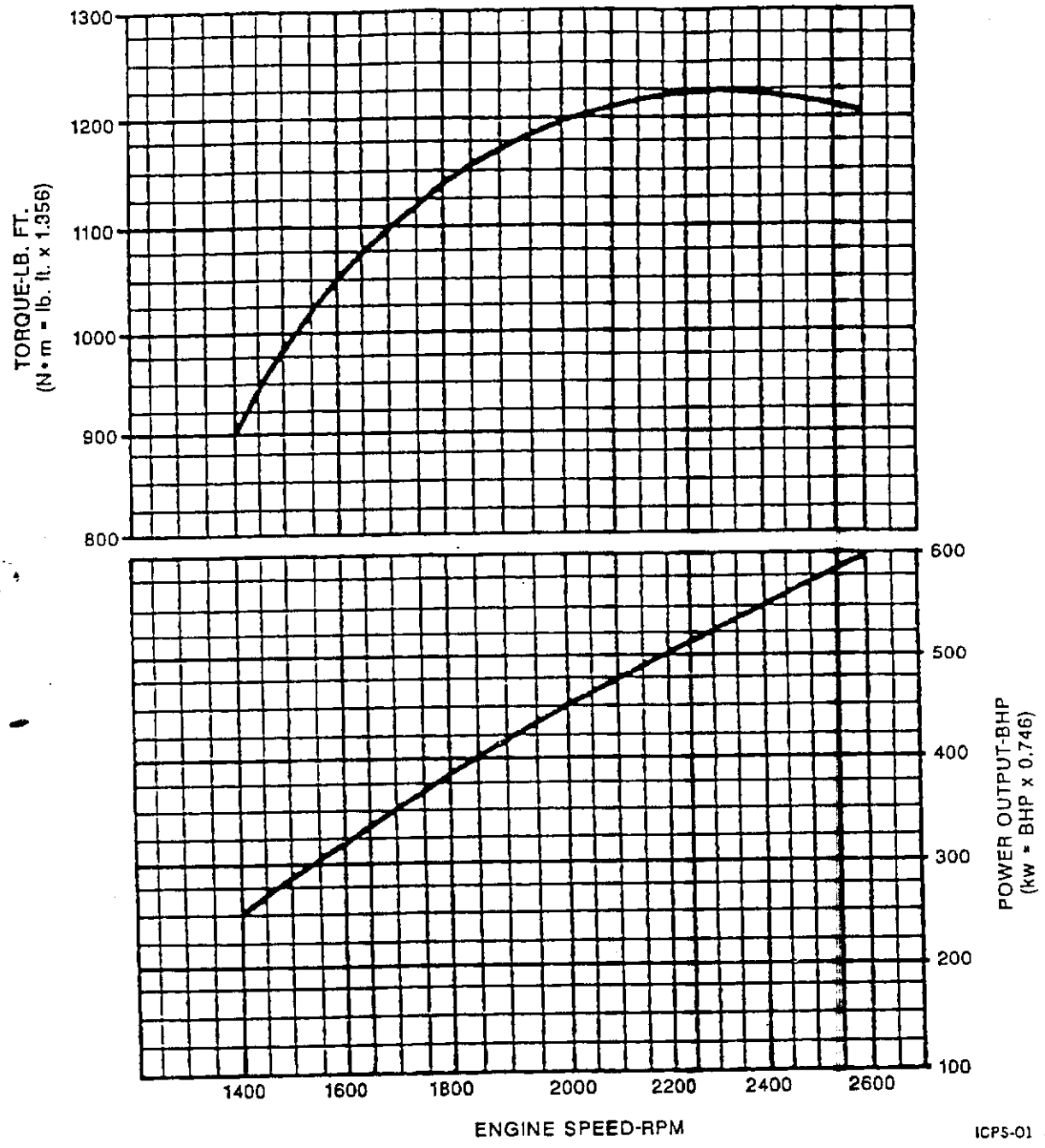


FIGURE 2. Engine performance (500 horsepower).

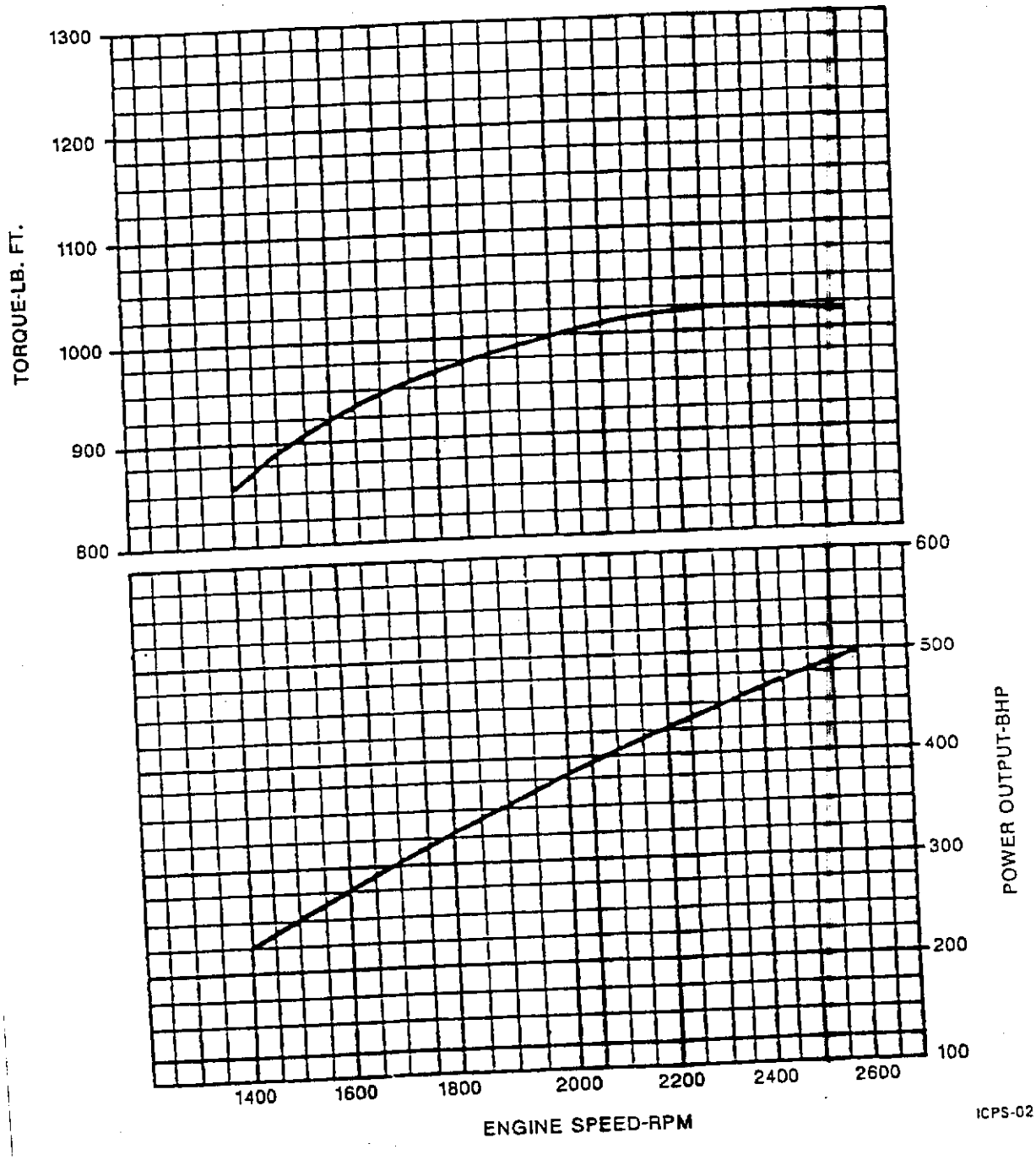


FIGURE 3. Command speed schedule (600 horsepower).

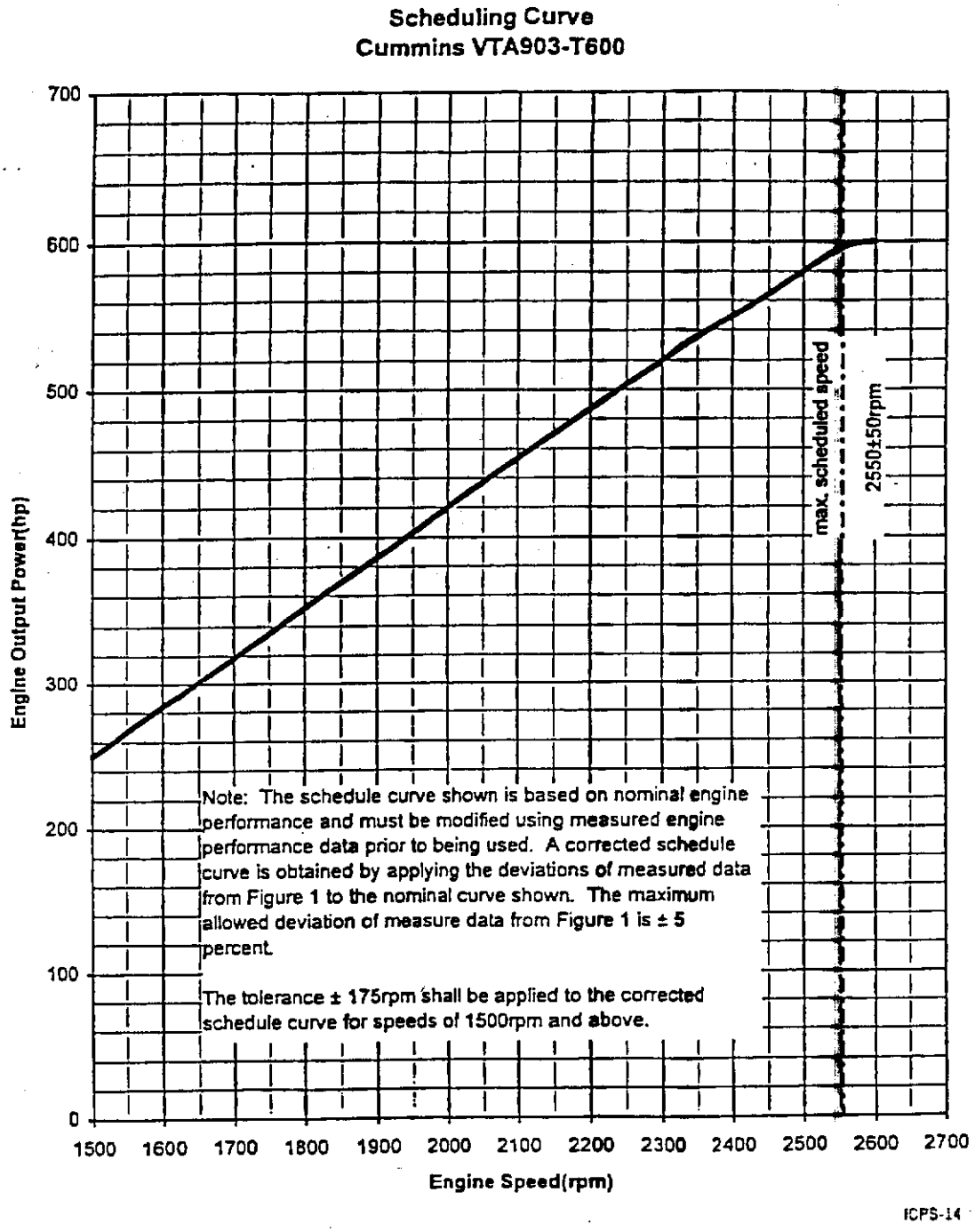


FIGURE 4. Command speed schedule (500 horsepower).

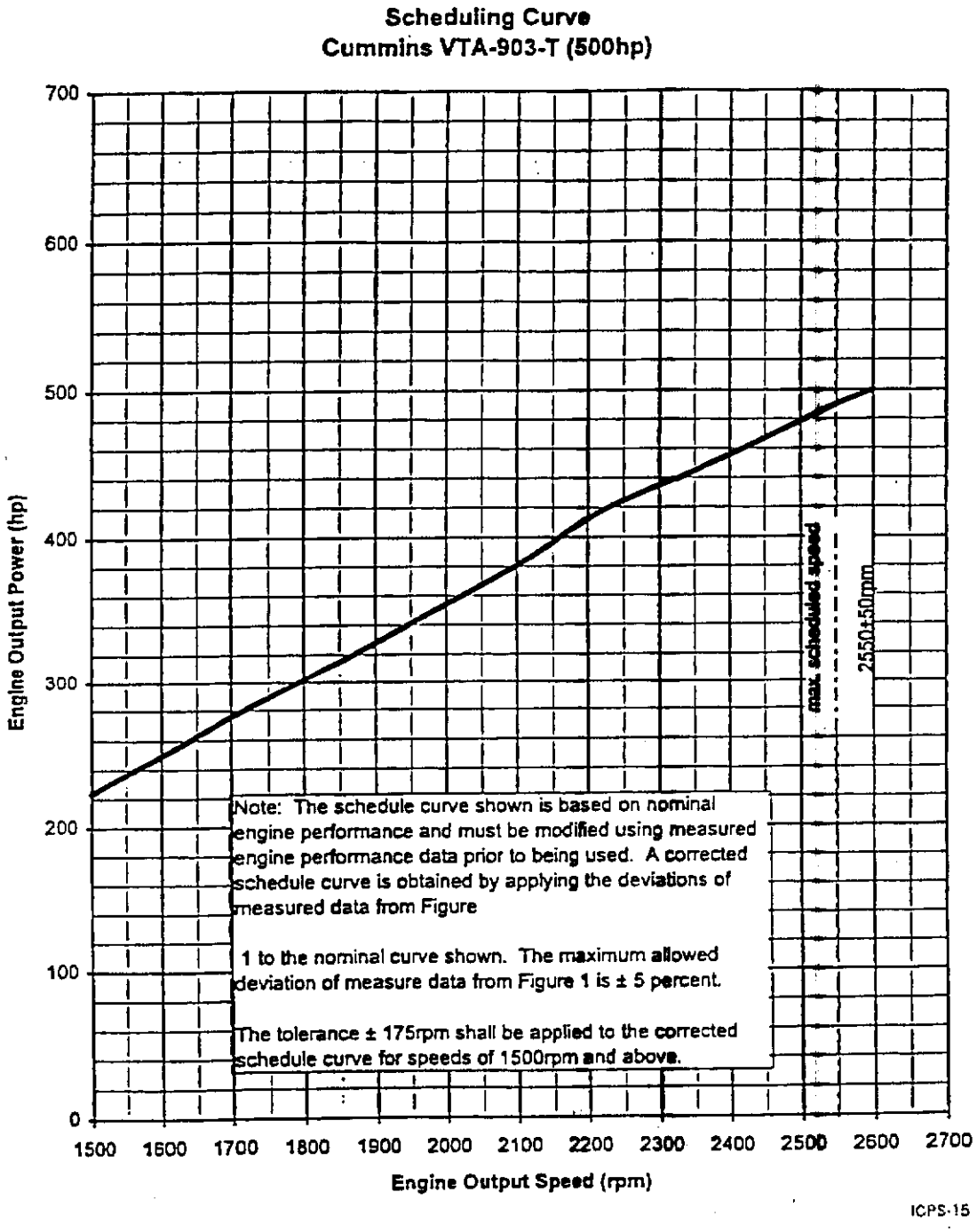


TABLE I. Output Speeds And Torques.

Item	Minimum Requirements		
	Output Torque (ft-lbs) 1/		Output Speed rpm 2/
	Input hp 600	Input hp 500	
a. Rated torque	9200		40
b. Rated forward speed	700	590	3200
c. Rated reverse speed	4010	3340	485
d. Rated steer torque	5600		70

1/ ft-lb = foot-pounds
2/ rpm = revolutions per minute

TABLE II. Transmission Output Speeds and Torques.

Input condition	Output speed (rpm) Minimum	Output Torque (ft-lb) Minimum	
		Input (A)	Input (B)
Input (A)	245	7000	5840
590 ± 10 hp	285	6180	5250
at	295 (reverse)	5825	4850
2550 ± 50 rpm	365	5230	4355
	585	3570	2975
Input (B)	475 (reverse)	4010	3340
490 ± 10 hp	785	2935	2445
at	980	2385	1985
2550 ± 50 rpm	1175	2000	1665
	1375	1620	1350
	1470	1495	1245
	1765	1300	1080
	1960	1185	985
	2355	1000	830
	2745	850	705
	2940	750	625
	3140	700	590
330 ± 5 hp	170	5450	
at	215	4700	
1900 ± 25 rpm	265	4005	
	530	2290	
	745	1760	
	955	1320	

TABLE III. Duty cycle.

Test Period	Duration Minutes	Engine hp Reference	Engine Rpm/torque		Output Rpm/Torque 1/	
Schedule A						
1	20	180	1300	727	280	2345
2	30	130	1250	550	280	1700
3	10	395	2170	956	335	4270
4	10	320	1980	848	1220L 1020R	1130
5	30	515 (500)	2550 ---	1060 (1010)	1260 ---	1700 (1650)
6	20	265	1800	773	615	1800
7	20	365	2180	875	2015	760
8	10	480 (430)	2250 ---	1120 (1010)	335 ---	4875 (4170)
9	30	350	2100	875	1010	1460
10	30	420	2300	959	2350	750
11	20	420	2300	959	1790	995
12	30	475	2500	997	1230	1610
13	30	500	2500	1050	2800	735
14	30	290	2120	720	1440	830
15	20	565 (500)	2550 ---	1160 (1010)	2940 ---	790 (680)
16	10	305	1800	890	335	3140
17	10	305	1800	890	280	3750 (rev)
18	10	320	1980	848	1020L 1220R	1130
Schedule B 19	25	340	2100	850		5111 4600*
20	15	460	2250	1075		5460 5192*
Schedule C 21	300	Idle	800	---	---	---

1/ Torque reading for reference only.
* When operating with 15W-40 oil.
( ) = with 500 hp input

b. Durability component life: The replacement of any transmission part(s) during the specified durability testing shall constitute a durability failure, except as allowed by the oil and main filter element and their associated consumable hardware.

3.3.5 Tow pump proof of function. Prior to the initiation and upon completion of each durability test, the tow pump shall demonstrate a back pressure of not less than 17 pound-force per square inch gage (psig) measured at the auxiliary pump sensing port while operating as specified in 3.3.14.

3.3.6 Service/park brakes.

3.3.6.1 Static (holding) torque. With the range selector in neutral and a service brake apply torque of not more than 100 ft-lb, each transmission output shaft shall be capable of holding a minimum of 2690 ft-lb with no slippage.

3.3.6.2 Dynamic (decelerating) torque. With no more than 138 ft-lb brake shaft apply torque, the transmission (when mated to a suitable power source) shall be capable of decelerating the transmission output and stop a 1634 pound-foot squared (lb-ft^2) rotating output inertia load (817 lb-ft^2 per side) from a speed of 3100 ±50 rpm in not more than 3.7 seconds.

3.3.7 Steer differential speeds. With the range selector in pivot and no load on either output shaft, the transmission shall be operated as follows:

a. With full left or right steer input applied (see 6.5.6), the output shaft total differential speed shall be a minimum of 600 rpm and 1025 rpm at, 1600 ±50 rpm and 2600 ±50 rpm input, respectively.

b. With 35 ±2 degrees of left or right steer applied (see 6.5.6), the output shaft total differential speed shall be a minimum of 250 and 450 rpm at 1600 ±50 rpm and 2600 ±50 rpm input, respectively.

3.3.8 No-load steer. With the range selector throttle positions and steer input signals as specified in Table IV, and at an input speed of 1200 ±100 rpm, the relative speeds of the output shafts shall be as specified therein. Steer input signal and output shaft rotations are defined in 6.5.6 and 6.5.7 respectively.

TABLE IV. No-Load Steer.

Range Selector Position	Steer Input Signal	Output Shaft Rotation	Output Shaft Speed - rpm (Minimum)	Transmission Throttle Signal
Reverse	Full Right	L-H fwd R-H rev	100 230	Minimum
	Full Left	L-H rev R-H fwd	230 100	Minimum
Pivot	Full Right	L-H fwd R-H rev	215 215	Minimum
	Full Left	L-H rev R-H fwd	215 215	Minimum
Forward	Full Right	L-H fwd R-H rev	230 100	Minimum
	Full Left	L-H rev R-H fwd	100 230	Minimum

3.3.9 Control

3.3.9.1 Control speed schedule. When operated with an Electronic Assembly (.see 12446501), the transmission shall demonstrate a capability of steady state operation in accordance with figure 3 (600 hp) or figure 4 (500 hp) as applicable. This capability shall be demonstrated by satisfying the requirements of 3.3.9.1.1 and 3.3.9.1.2. Use of either 600 hp or 500 hp input conditions shall be as specified by the acquisition document (see 6.2).

3.3.9.1.1 Command speed schedule. When tested in accordance with the procedures specified in 4.7.3.2.11.1, the transmission command speed schedule shall maintain an input engine speed to within ±175 rpm of the schedule curve shown in Figure 3 (600 hp) or Figure 4 (500 hp) as applicable. When the transmission is operated in the first range hold or reverse range selector positions, the command speed schedule is not required to control the engine speed within the specified limits at light loads (less than 3500 ft-lb).

3.3.9.1.2 Maximum governed speed. When tested in accordance with the procedures specified in 4.7.3.2.11.2 and with the engine operated at wide open throttle command speed of 2550 ±20 rpm, the transmission shall maintain input engine speed at ±80 rpm of the initial setting over an output speed range of 250 ±20 rpm to 2600 ±20 rpm with a steady state loading at the transmission output shafts.

3.3.9.2 Steer gain response. When operated in accordance with 4.7.3.2.11.3, total output shaft speed at minimum transmission throttle input shall not exceed an average of 20 percent of the total output shaft speeds when operated at maximum transmission throttle signal with neither steer input exceeding 23 percent of the maximum output speed.

3.3.9.3 Disconnect clutch control.

3.3.9.3.1 Disconnect clutch control-powered operation. The transmission shall provide the capability to allow it to be disengaged from the engine input while maintaining constant power-takeoff (PTO) drive gear rotation.

3.3.9.3.2 Disconnect clutch control-default. The transmission shall default to a disconnect clutch disengaged mode if electrical power is lost while the engine is running. The third range pilot shall default to an open or on position.

3.3.9.4 Controller shaft operating forces. Operating forces for the input shafts shall be as follows:

a. Actuating torque required to rotate the steer input through full travel on either side of neutral shall not exceed 30 in-lb of torque.

b. Actuating torque required to rotate the throttle input shaft through full travel (44 ±1 degrees) shall not exceed 15 in-lb torque.

3.3.9.5 Cut-in speed. The transmission shall demonstrate zero output speed rotation at idle conditions.

a. Output shaft rotation shall be initiated by engine speed of 1000±100 rpm when the range selector is in the drive position.

b. Output shaft rotation shall be initiated by engine speed of 1200±100 rpm when the range selector is in the reverse or low range hold positions.

3.3.9.6 Maximum forward ratio. With no output loads the transmission shall demonstrate a minimum ratio (output speed divided by input speed) of 1.26.

3.3.9.7 Maximum reverse ratio. With no output loads the transmission shall demonstrate a minimum ratio (output speed divided by input speed) of 0.194.

3.3.10 Transmission frictions.The range selector input speeds and the maximum input torques shall be as specified in Table V.

TABLE V. Transmission friction.

Input speed	Range	Max Input Torque (ft-lb)
800 ±25 rpm	Neutral	35
800 ±25 rpm	Pivot	60
1600 ±25 rpm	Pivot	90
2600 ±25 rpm	Pivot	122

3.3.11 Cooling point heat rejection. With input oil at 260 ±2.5°F and the range selector in forward, the transmission shall be operated to demonstrate the following using new oil as specified in 3.3 (reference MIL-PRF-2104), and including an induced minimum demand flow leakage of 5.2 gallons per minute (gpm) to simulate PTO load effects..

a. Grade 30. The transmission shall demonstrate a heat rejection of not more than 7950 British thermal unit (BTU) per minute 1/ for an input speed and power of 2250 ±50 rpm and 430 ±5 hp respectively with an applied load of 5670 ±50 ft-lb total output load to the output shaft (2810 ft-lb minimum each side).

b. Grade 15W-40 oil. The transmission shall demonstrate a hp loss heat rejection of not more than 8200 BTU per minute 1/ for an input speed and power of 2250 ±50 rpm and 430 ±5 hp respectively with an applied load 5670 ±50 ft-lb total load to output shaft (2810 ft-lb minimum each side).

3.3.12 Maximum speed limiter. With inlet oil temperature of 260 ±2°F the transmission shall limit engine speed to 2250 ±50 rpm when operating at ratios of less than 0.11.

1/ All heat rejection requirements are based on a 430 hp input apply condition.

3.3.13 Torque, With the range selector in the forward position, the transmission shall produce a minimum average (left hand and right hand) output speed of 155 rpm when using grade 30 oil, and 150 rpm when using grade 15W-40 oil for an applied total load of 6650 ±50 ft-lb to the output shafts (3300 ft-lb minimum per side), with an input speed of 2500 ±50 rpm and 840 ±20 ft-lb of input torque.

3.3.14 Loads With the range selector in the forward position, the transmission shall produce a minimum total output torque of 618 ft-lb (309 ft-lb minimum per side) at an output speed of 2500 ±50 rpm with an input speed of 2500 ±50 rpm and 840 ±20 ft-lb of input torque.

3.3.15 Slope operation. With the oil level set at the ADD mark on the dipstick, the transmission shall be observed to operate satisfactorily at the following slopes and directions:

a. Transmission 70 percent up or vehicle 60 percent up.

b. Transmission 70 percent down or vehicle 60 percent down.

c. Transmission 45 percent left and right side, or vehicle 40 percent left and right side.

3.4 Environmental conditions.

3.4.1 Cold temperature. The ability of the transmission to withstand the required environmental conditions shall be demonstrated by meeting the requirements specified herein. Cracked or broken parts resulting from the specified test procedures shall constitute a test failure.

3.4.1.1 Cold storage. The transmission shall be capable of withstanding storage temperature of -70°F for not less than 8 hours.

3.4.1.2 Cold cranking torque. The transmission and oil temperatures shall be stabilized at -60°F but not less than 10°F above the stable pour point of the oil. With the transmission range selector in neutral, the net input torque required to rotate the transmission input shaft at the engine cranking speed shall not exceed 490 ft-lb.

3.4.1.3 Proof of function. With the transmission sump oil temperature stabilized at -25°F, the transmission shall be operated to demonstrate the capability of steering, braking and operating in all ranges.

3.4.2 Steam and waterjet cleaning. When tested in accordance with the steam cleaning and waterjet washing procedures of 4.7.4.4, there shall be no evidence of ingestion of water or cleaner into the interior of the transmission.

3.5 Electromagnetic radiation. When operated through the entire range of ratio, both forward or reverse, electromagnetic radiation shall not exceed the limits identified by MIL-STD-461, tailored in accordance with Appendix A.

3.6 Reliability. Mean miles between failure (MMBF) to be demonstrated by the transmission for the conditions specified in the following subparagraphs shall be a minimum of 8500 miles during the first 6000 miles or equivalent hours of operation when tested as specified by the acquisition document (see 6.2).

3.6.1 Reliability assessment. All failures shall be defined and scored in accordance with Fighting Vehicle Systems RAM-D Failure Definition and Scoring Criteria. Calculations shall be performed on point estimate basis for a sample population representing a total accumulation of not less than 30000 miles or equivalent hours of operation.

3.6.2 Duty cycle composition. For the purpose of demonstrating the MMBF during the first 6000 miles of transmission operation, the total duty cycle shall be applied such that not more that 50 percent of the total represents the effects of a 66000-pound gross vehicle weight (GVW) (see 6.1) with the balance at 60000-pound GVW. The duty cycle shall also be structured to represent a total mileage or equivalent time accumulation per unit tested as follows:

a. Paved roads: 1260 miles

b. Secondary roads: 2700 miles

c. Cross-country: 2040 miles

3.7 Maintainability.

3.7.1 Daily crew checks. Daily crew checks and services shall require no more than 0.59 manhours. The crew is defined as two people: driver and gunner.

3.8 Nameplates and product marking.

3.8.1 Nameplates. Nameplate material and construction shall conform to A-A-50271, Composition A, Class 2, or Composition C. Composition C material shall conform to GG-P-455, Type II, Grade A, Class 1. The nameplate shall be attached with suitable metal fasteners to achieve a permanent installation.

3.8.2 Product marking. Unless otherwise specified in the contract or order, the transmission shall be identified in accordance with MIL-STD-130, and the markings shall include:

a. Drawing 12446500.

b. Transmission, Crossdrive, Hydromechanical, CII XM92026A6.

c. Name of manufacturer and cage code.

d. Manufacturer's part number, serial number and date manufactured.

3.9 Workmanship. Workmanship shall be of a quality which assures a product free from cracked, broken, loose or dented parts or components. Also, there shall be no burrs, sharp edges, or other defects which may affect serviceability and performance.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection . Unless otherwise specified in the contract or purchase order (see 6.2), the contractor is responsible for the performance of all inspection requirements (examination and test) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform or witness any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all the requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspection. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.4)

b. Quality conformance inspection (see 4.5).

   1. Examination (see 4.5.2).

   2. Tests (see 4.5.3).

c. Control tests (see 4.6).

4.3 Inspection conditions. Unless otherwise specified (see 6.2), all inspections shall be conducted under the following controlled ambient conditions:

a. Temperature: 73 ±18°F.

b. Relative humidity: 50 ±30 percent.

c. Atmospheric pressure: 28.5 +2/-3 inches mercury (in Hg).

4.4 First article inspection. Unless otherwise specified (see 6.2), the Government shall select one transmission produced under the production contract for first article inspection. First article samples shall be inspected as specified in Table VI. Approval of the first article sample by the Government shall not relieve the contractor of his obligation to supply transmissions that are fully representative of those inspected as a first article sample. Any changes or deviation of the production units from the first article sample shall be subject to the approval of the contracting officer. The reliability demonstration shall be performed as part of the first article inspection when specified by the acquisition document (see 6.2).

4.4.1 First article inspection failures. Deficiencies found during, or as a result of, the first article inspection shall be cause for rejection of the first article sample until evidence has been provided by the contractor that corrective action has been taken to eliminate the deficiency. Any deficiency found during, or as a result of first article inspection, shall be evidence that all items already produced prior to completion of the first article test are similarly deficient unless contrary evidence satisfactory to the contracting officer is furnished by the contractor. Such deficiencies on all items shall be corrected by the contractor. The Government will not accept products until first article inspection is completed to the satisfaction of the Government. Any retrofit of unconditionally accepted transmissions required by the procuring activity due to the incidents or failures as specified herein shall be accomplished by the supplier as a change to the acquisition contract or document.

4.4.1.1 Teardown and inspection. At the conclusion of first article testing the transmission and its major subassemblies shall be disassembled and inspected by the supplier in the presence, if so directed, of the procuring activity representative. Disassembly will be accomplished to the extent required for inspection and repair of major subassemblies and/or components.

4.4.1.2 Correction and assembly. If there is evidence of a test induced defect on the transmission and its major components requiring correction, such corrections shall be made by the supplier while the transmission is in its disassembled state. The supplier shall report all such defects to the procuring activity. The corrected transmission shall be reassembled and shall meet the quality conformance inspection (QCI) test requirements specified in Table VI.

TABLE VI. Classification of inspections.

Title	Requirement	Inspection	First Article	QCI		Control	
				Examination	Test	Level A	Level B
Materials, design and construction	3.2 thru 3.2.6 and 3.2.8	4.7.1	X				
Identification and workmanship	3.8 and 3.9	4.7.2	X	X			
Oil leakage	3.3.1	4.7.3.2.1	X		X		
Input power	3.3.2.1	4.7.3.2.2	X				X
Output power (see Table I)	3.3.2.2	4.7.3.2.3 thru 4.7.3.2.5	X				X
Output torques for constant loads	3.3.3	4.7.3.2.6	X				X
Durability	3.3.4	4.7.3.2.7.1 4.7.3.2.7.2 4.4.3.2.7.3	X			X	X
Tow pump proof of function	3.3.5	4.7.3.2.7.4	X		X		
Static (holding) torque	3.3.6.1	4.7.3.2.8.1	X			X	X
Dynamic (decelerating) torque	3.3.6.2	4.7.3.2.8.2	X				X
Steer differential speeds	3.3.7	4.7.3.2.9	X				X
No-load steer	3.3.8	4.7.3.2.10	X		X		
Command speed Schedule	3.3.9.1.1	4.7.3.2.11.1	X				X
Maximum governed Speed	3.3.9.1.2	4.7.3.2.11.2	X				X
Steer gain Response	3.3.9.2	4.7.3.2.11.3	X			X	X
Disconnect clutch control-powered operation	3.3.9.3.1	4.7.3.2.11.4	X		X		

TABLE VI. Classification of inspections. (continued)

Disconnect clutch control-default	3.3.9.3.2	4.7.3.2.11.5	X		X		
Control shaft operating forces	3.3.9.4	4.7.3.2.11.6	X			X	X
Cut-in speed	3.3.9.5	4.7.3.2.11.7	X		X		
Rated fwd ratio	3.3.9.6	4.7.3.2.11.8	X				X
Rated reverse ratio	3.3.9.7	4.7.3.2.11.9	X		X		
Transmission friction	3.3.10	4.7.3.2.12	X		X		
Cooling point heat rejection	3.3.11	2.7.3.2.13 4.7.3.2.13.1	X			X	X
Max speed Limiter	3.3.12	4.7.3.2.14	X				X
Torque	3.3.13	4.7.3.2.15	X		X		
Load	3.3.14	4.7.3.2.16	X		X		
Slope operation	3.3.15	4.7.3.2.17	X				
Cold Storage	3.4.1.1	4.7.4.1	X				
Cold cranking torque	3.4.1.2	4.7.4.2	X				
Proof of function	3.4.1.3	4.7.4.3	X				
Steam and waterjet cleaning	3.4.2	4.7.4.4	X				
Electro-magnetic radiation	3.5	4.7.5	X				
Reliability	3.6	4.7.6	X				
Maintainability	3.7.1	4.7.7	X				

TABLE VI. Classification of inspections. (continued)

Interface	3.2.7.1	4.7.8.1	X	1/			
Installation control	3.2.7.2	4.7.8.2	X				
Packaging	5.	4.8	X	X			

1/ Per Note 11 of Drawing 12446504

4.5 QCI. QCI shall consist of the following examinations and tests:

a. Examination (sampling inspection), see 4.5.2.

b. Tests (100 percent inspection), see 4.5.3.

4.5.1 Sampling for QCI examinations.

4.5.1.1 Lot formation. Each lot shall be defined as 50 consecutively produced transmissions unless otherwise defined by the contract or purchase order (see 6.2).

4.5.1.2 Sample. The sample for examination shall be randomly selected from lot specified in 4.5.1.1.

4.5.2 Examination. The sample selected in accordance with 4.5.1.2 shall be examined as specified in 4.7.2.

4.5.2.1 QCI examination failure. Any failure of the selected sample in either the Major/Minor categories for the transmission shall constitute a failure of the item. The rejected item may be repaired or corrected and resubmitted for inspection.

4.5.3 Tests. All transmissions shall be subjected to the QCI tests specified in Table VI.

4.5.3.1 QCI test failure. Failure of the transmission to pass the QCI tests shall be cause for the Government to refuse acceptance of the transmission. Any transmission containing one or more defects either shall be corrected and re-examined, or retested and resubmitted without defects for Government acceptance. Resubmitted transmissions shall be kept separate from new transmissions, and shall be clearly identified as resubmitted transmissions.

4.6 Control tests. Control tests shall be conducted on one transmission from each lot as defined in 4.5.1.1 selected as specified in 4.6.1. The transmission shall be subjected to the tests specified in Table VI.

4.6.1 Levels.

4.6.1.1 Level A. Level A tests shall be run on one transmission randomly selected by the Government from each lot.

4.6.1.2 Level B. Level B tests shall be run on one transmission randomly selected by the Government from one of every eight consecutively produced lots or every 6 months whichever occurs first.

4.6.2 Failure. Failure of any transmission to pass any of the specified control tests shall be cause for the Government to refuse acceptance of additional production transmissions, until action taken by the contractor to correct defects and prevent recurrence has been approved by the Government.

4.7 .Methods of inspection.

4.7.1 Materials, design and construction. Unless otherwise specified herein, conformance to 3.2 through 3.2.6 and 3.2.8 shall be determined by inspection of contractor records providing proof or certification that design, construction, processing and materials conform to requirements. Applicable records shall include drawings, specifications, design data, receiving inspection records, processing and quality control standards, vendor catalogs and certifications, industry standards, test reports and rating data.

4.7.2. Identification and workmanship. Compliance to 3.8 and 3.9 shall be visual inspection and use of SIE.

4.7.3 Performance tests.

4.7.3.1 Test equipment configuration and conditions.

4.7.3.1.1 Transmission orientation. The terms "right" and "left" as apply to the transmission output shafts are defined by 6.5.9.

4.7.3.1.2 Installation. The transmission shall be installed on a test stand equipped to conduct the test procedures specified in 4.7.3.2. Input and output shafts, steer and control connections, pressure and temperature outlets and oil circuit lines shall be properly connected so as to permit operations as specified herein. Test setup and operation shall be approved by the transmission supplier responsible for inspections as specified in 4.1.1.

4.7.3.1.3 Power sources.

4.7.3.1.3.1 Mechanical power. A source of power sufficient to supply the input hp and rpm requirements as specified in figure 1 or 2, as applicable, shall be made available.

4.7.3.1.3.2 Electrical power. Electrical control signals and power requirements shall be as specified in 12446252.

4.7.3.1.4 Instrumentation. Instrumentation shall be provided to make the required measurements herein. All standard measuring equipment shall be calibrated at regular intervals to industry accepted standards, traceable to standards of the National Bureau of Standards. Records of such calibrations shall be made available to the Government.

4.7.3.1.5 Oil. Oil conforming to 3.3 shall be used and maintained within the operating range of the oil level dipstick during transmission operation. Preservative oil conforming to MIL-PRF-21260 may be substituted for MIL-PRF-2104 when conducting the QCIs specified in Table VI.

4.7.3.1.5.1 Oil level. To establish the transmission operating oil level, fill the transmission with oil sufficient to raise the sump oil level to the "safe to operate" oil mark on the dipstick. With the range selector in first range hold, operate the transmission at an input speed of 1400-1500 rpm until the oil from the external oil cooler is 190 +10°F unless the transmission is operating for the first time. When warming a new transmission upon attaining 150°F oil inlet temperature, the following break-in procedures shall be utilized:

a. Perform 12 shift cycles starting at the following initial settings:

Range selector in Forward
Input speed 2000 ±50 rpm
Input torque 800 ±25 ft-lbs
Output speed 300 ±25 rpm per side

Upon stabilizing at these initial conditions, dynamometer loads shall be decreased until the output speeds reach 2000 rpm when they shall be increased again until attaining the initial conditions. After 12 cycles, return throttle to idle position.

b. With the range selector in Reverse and the dynamometer loads off, raise the input speed to 1500 ±50 rpm and hold for 1 minute - return to idle.

c. With the range selector in Forward and the dynamometer loads off, raise the input speed to 2000 ±100 rpm and hold for 1 minute -return to idle.

NOTE: If the drag load from the dynamometer does not permit the transmission to shift into third range, then input speed may be increased until the transmission is running stable in third range.

d. With the range selector in Reverse and the dynamometer loads off, raise the input speed to 2000 ±50 rpm and hold for 1 minute - return to idle.

e. With the range selector in Forward and the dynamometer loads off, raise the input speed to 2250 ±100 rpm and hold for 1 minute -return to idle

NOTE: If the drag load from the dynamometer does not permit the transmission to shift into third range, then input speed may be increased until the transmission is running stable in third range.

f. With the range selector in Reverse and the dynamometer loads off, raise the input speed to 2300 ±50 rpm and hold for 1 minute - return to idle.

g. Perform 6 shift cycles starting at the following initial settings:

Range selector in Forward, input speed 2000 ±50 rpm, input torque 800 ±25 ft-lbs, output speed 300 ±25 rpm per side.

Upon stabilizing at these initial conditions, dynamometer loads shall be decreased until the output speeds reach 2000 rpm when they shall be increased again until attaining the initial conditions. After 6 cycles, return to idle.

4.7.3.1.6 Oil pressure. During all testing, the oil pressure drop between the transmission outlet and inlet from the external oil cooler shall be no greater than 34 pounds per square inch (psi) at a flow of 65 gpm.

4.7.3.1.7 Oil temperature. Unless otherwise specified in 4.7.3.2, the oil inlet temperature at the transmission inlet from the external oil cooler shall be maintained at 190 ±5°F.

4.7.3.1.8 Controls. The initial position of the range selector is in neutral, service brakes are released, initial position of the throttle input is against the counterclockwise stop, and the wide-open throttle, or full throttle, position shall be a clockwise rotation of 36 degrees minimum from the initial position; and the initial position of the steer control lever is the neutral steer input with full travel being a minimum of 55 degrees rotation in either direction. Unless otherwise noted, linkages and transmission inputs shall be adjusted in accordance with TM-9-2350-284-20-1.

4.7.3.2 Test procedures.

4.7.3.2.1 Oil leakage. To determine compliance with 3.3.1, the transmission shall be washed (see 6.5.5) prior to operation. With the range selector in the forward position, and input speed of not more than 2550 rpm; total time of 10 minutes will be spent while the transmission is operated in all ranges varying the load applied to the outputs and under no-load steer conditions in Table IV. Following a 10-minute set period (engine off), the transmission shall be visually inspected for oil leakage.

4.7.3.2.2 Input power. Compliance with 3.3.2.1 shall be demonstrated during the output torque measurements specified in 4.7.3.2.11.1.

4.7.3.2.3 Rated torque. To determine compliance with the rated torque requirement specified in Table I, the transmission shall be mated to an approved power source having a 500 hp minimum rating. A minimum dynamic output loading of 6000 ft-lb capacity is required for both the left and right-hand transmission outputs at a speed range of zero through 100 rpm.

a. With the engine at idle, select the forward range. The steer input shall be at neutral (zero steer).

b. With separate engine and transmission input throttle controls, raise the engine speed to 2500 ±50 rpm while increasing the dynamometer loads to the output.

c. With the input stabilized at 2500 ±50 rpm and 480 hp minimum, continue to increase the left and right dynamometer torques evenly until the minimum conditions of rated torque requirement specified in Table I have been achieved.

d. Release dynamometer loads while returning input controls to idle.

4.7.3.2.4 Rated speeds. Rated speeds shall be demonstrated as follows.

4.7.3.2.4.1 Rated forward speed. Transmission shall be operated with separate engine and transmission throttle controls and the range selector in forward. With the transmission throttle at wide open, increase the engine throttle and adjust the output loads to achieve the minimum speed requirements of Table I. Confirm that the input is at 2575 ±50 rpm and 600 ±15 hp; output speeds and torques shall meet or exceed the minimum requirements as specified in Table I.

4.7.3.2.4.2 Rated reverse speed. Transmission shall be operated with separate engine and transmission throttle controls and the range selector in reverse. With the transmission throttle at wide open, increase the engine throttle and adjust the output loads to achieve the minimum speed requirements of Table I. Confirm that the input is at 2575 ±50 rpm and 600 ±15 hp; output speeds and torques shall meet or exceed the minimum requirements as specified in Table I.

4.7.3.2.5 Rated steer torque. To determine compliance with the rated steer torque requirement specified in Table I, the transmission shall be mated to an approved power source having a 500 hp minimum rating. A minimum dynamic output loading of 6000 ft-lb capacity is required for both the left and right-hand transmission outputs at a speed range of zero through 100 rpm.

a. With separate engine and transmission throttle inputs, the engine input speed at idle and the range selector in the pivot steer position, rotate the steer input shaft to the full right steer position and secure.

b. Raise the engine speed to 2500 ±50 rpm while increasing the dynamometer load to the left transmission output only.

c. With the input conditions stabilized at 2500 ±50 rpm and 480 hp minimum, continue to increase the left dynamometer load until the minimum applicable conditions specified in Table I have been achieved.

d. Release the load to the left output while returning the input controls to idle.

e. Repeat steps a. through d. for a left steer signal with the load applied to the right transmission output only.

4.7.3.2.6 Output torques for constant loads. To determine compliance with 3.3.3, the transmission shall be operated at the output speeds and input conditions specified in Table II, and the output torques for each condition recorded.

4.7.3.2.7 Durability. To determine compliance with 3.3.4, the transmission shall be operated in accordance with the performance and duty cycle requirements specified in Table VI. During the durability and postdurability testing, the transmission shall receive oil level checks daily and oil filter element changes at 110-hour increments, minimum. In the event of a need-to-repair incident(s), the transmission shall be repaired in accordance with the latest approved maintenance procedures so as to continue testing through the prescribed duration.

4.7.3.2.7.1 First article durability testing. First article durability testing shall be 440 hours (excluding performance testing) divided into four periods of 110 hours each. Each 110-hour period of the test shall consist of 16 cycles through schedule A, and two cycles through schedules B and C as specified in Table III. Test periods within each cycle may run in any order within each cycle, and the engine idle time of schedule C may be split up throughout the durability test. The total of the cycles shall be comprised of the following cycle schedules:

a. Seven cycles through schedule A with 190°F inlet oil.

b. One cycle through schedule A with 230°F inlet oil.

c. One cycle through schedule B with 260°F inlet oil.

d. One cycle through schedule C with 190°F inlet oil.

Test period changes shall be accomplished dynamically, however only the steady state time on the described point shall be considered for accumulation of the durability operation. Compliance with the predurability performance requirements of 3.3 shall be demonstrated by performance of FAI inspection requirements specified in Table VI. Post durability performance requirements shall be demonstrated by performance of inspection requirements of FAI inspection requirements specified in Table VI, less the requirements specified in 3.3.2.2, (Line a. Rated Torque and Line b. Rated Steer,Torque only) and 3.3.6.2.

4.7.3.2.7.2 Control durability test, Level A. Performance requirements specified in Table VI shall be demonstrated prior to and following the prescribed durability operation. Durability testing shall be accomplished by running the transmission as specified by Table VII once.

TABLE VII. Level A durability schedule.

Test Point	Trans Range Reference	Duration Minutes	Input Rpm	Input Torque	Output rpm	
					LH	RH
1	LH pivot	15	1450	590	-290	290
2	1	15	2170	956	335	335
3	2	20	1625	421	715	715
					950	450
					450	950
4	3	15	2350	959	2350	2350
5	3	15	2120	720	1440	1440
6	1	20	1525	500	230	230
7	Rev	15	2170	956	-400	-400
					-400	-200
					-200	-400
8	RH pivot	15	1450	550	280	-280
9	1	20	1525	500	230	230
10	2	20	2350	1040	1285	1285
11	3	20	2300	959	1800	1800
					1550	2050
					2050	1550
12	2	20	1800	773	615	615
13	1	20	2350	1100	345	345
14	3	15	2120	720	1440	1440
15	3	15	2350	959	2350	2350
16	2	20	2100	890	1010	1010
					890	1125
					1125	890
17	3	15	2350	1050	2500	2500
18	2	20	1625	421	715	715
					950	450
					450	950
19	1	20	2350	1100	345	345
20	2	20	1800	773	615	615
21	3	20	2350	1000	2500	2500
					2400	2600
					2600	2400
22	2	20	2350	1000	1230	1230
23	1	20	2110	930	260	260
					200	300
					300	200
24	Rev	15	2170	956	-400	-400
					-400	-200
					-200	-400

4.7.3.2.7.3 Control durability test, Level B. Performance requirements specified in Table VI shall be demonstrated prior to and following the prescribed durability operation. Durability tests conducted during control test inspection shall not exceed 100 hours, excluding performance test requirements. The sequence of cycles specified in Table III shall be as follows:

a. Thirteen cycles through schedule A with 190°F inlet oil.

b. Two cycles through schedule A with 230°F inlet oil.

c. Two cycles through schedule B with 260°F inlet oil.

d. One cycle through schedule C with 190°F inlet oil.

4.7.3.2.7.4 Tow pump proof of function. To determine compliance with 3.3.5 when operated in accordance with 4.7.3.2.16 at steady state conditions, the presence of 17 psig (or greater) pressure, measured at the auxiliary pump sensing port, shall be evidence of tow pump function.

4.7.3.2.8 Service brakes.

4.7.3.2.8.1 Static (holding) torque. To determine compliance with 3.3.6.1, with the range selector in neutral, apply no greater than 100 ft-lb torque to each of the transmission service brake shafts. While maintaining this torque, apply a minimum of 2690 ft-lb torque to the output shafts; no rotation of the output shafts is permissible.

Points 3, 7, 11, 16, 18, 21 and 23 consist of applying an appropriate steer signal to achieve the output speed differentials. Each condition shall be run for 1 minute including the transition time to that point. Total elapsed time from the initial set-up condition shall constitute the required duration of the subject point.

4.7.3.2.8.2 Dynamic (decelerating) torque. To determine compliance with 3.3.6.2, the transmission shall be operated with the specified inertia loading as follows:

a. With the range selector in forward, increase the throttle input until the engine speed is at 2550 ±50 rpm and the input torque is at a minimum of 950 ft-lb; adjust the dynamometer loads to achieve 3100 ±50 rpm output speeds.

b. Rapidly return the input throttle to the idle position and immediately apply the service brakes to the left and right outputs simultaneously. (NOTE: Do not exceed apply torque specified in 3.3.6.2)

c. The elapsed time from full brake apply force to the complete stop of the output shafts shall be no greater than the time specified in 3.3.6.2.

4.7.3.2.9 Steer differential speeds. To determine compliance with 3.3.7 the transmission shall be operated with separate transmission and engine throttle inputs as follows:

a. Maintain a zero transmission input and apply a full right steer input with no load applied to the output shafts, and with the range selector in pivot steer, raise the engine to 1600 ±50 rpm and allow conditions to stabilize. Record the input and output speeds and directions. Repeat with a full left steer signal.

b. Maintain a zero transmission input and apply a full right steer input with no load applied to the output shafts, and with the range selector in pivot steer, raise the engine speed to 2600 ±50 rpm and allow conditions to stabilize. Record input and output speeds and directions. Repeat with a full left steer signal.

c. Repeat steps a. and b. with an applied steer signal of 35 ±2 degrees.

4.7.3.2.10 No-load steer. To determine compliance with 3.3.8, the transmission shall be operated with separate transmission and engine throttle inputs in accordance with Table IV. At an input speed of 1200 ±100 rpm, directions of rotation and relative speeds of the output shafts shall be recorded. Full steer inputs shall be applied prior to raising throttle input.

4.7.3.2.11 Control.

4.7.3.2.11.1 Command speed schedule. To determine compliance with 3.3.9.1.1, the transmission shall be operated as follows:

a. Connect the transmission to a power source complying with the requirements shown on figure 3 (600 hp) or figure 4 (500 hp) as applicable.

b. With the range selector in forward, apply a full throttle input signal and adjust the dynamometer loads to achieve 700 ±100 rpm output speed. Allow conditions to stabilize and record the input and output speeds and torques.

c. Reduce the throttle signal by 3-degree increments readjusting the loads as required to maintain 700 ±100 rpm output speeds above 1750 rpm engine speeds and 400 ±50 rpm output speeds below 1750 rpm engine speeds; allow conditions to stabilize. Record the input and output speeds and torques at each interval until an input speed of 1500 rpm is obtained.

d. Compute the input hp (input speed x input torque/5252) and plot the test derived data onto figures 3 or 4 as applicable to determine conformance. Confirm demand speed is 2550 ±50 rpm at throttle signals 36 degrees or greater from the idle position.

4.7.3.2.11.2 Maximum governed speed. To determine compliance with 3.3.9.1.2, the transmission shall be operated as follows:

a. With the range selector in forward, apply a full throttle input and adjust the dynamometer loads to stabilize at an output speed of 250 ±20 rpm per side. Record the input and output speeds and torques.

b. While maintaining full throttle input, adjust the dynamometer loads to obtain stabilized output speeds of 300, 950, 1600, 2250 and 2600 ±20 rpm per side. Record the input speeds and torques for each of the points.

c. To comply with 3.3.9.1.2 the engine speeds in step b. shall not vary more than ±80 rpm from the engine speed recorded in step a.

4.7.3.2.11.3 Steer gain response. To determine compliance with 3.3.9.2, the transmission shall be operated in pivot steer using separate engine and transmission throttle inputs under the following conditions:

a. At idle, apply a left steer signal of 55 ±2 degrees.

b. Keeping the transmission throttle input at zero, raise the engine speed to 1200 ±100 rpm with no loads on the dynamometers. Record the input and output speeds.

c. Repeat step b. with the transmission throttle input at full throttle signal.

d. Repeat steps a. through c. with a right steer input.

e. Compare the total output speed of step b. with that of step c. for compliance with 3.3.9.2.

4.7.3.2.11.4 Disconnect clutch control powered operation. To determine compliance with 3.3.9.3.1, the transmission shall be operated as follows:

a. With the range selector in neutral, apply a minimum of 30 degrees right steer signal, raise the input speed to a minimum of 1200 rpm and observe that there is no rotation of the output shafts.

b. Repeat step a. with the range selector in pivot steer. Rotation of the output shafts is evidence that the disconnect clutch has engaged.

4.7.3.2.11.5 Disconnect clutch control default. To determine compliance with 3.3.9.3.2, disconnect the control cable to the IA plate while operating at idle disengaged conditions (neutral). Verify that the auxiliary and make-up pressures do not vary more than 20 psig from the original readings before the cable was disconnected. Note that the first range pilot pressure drops to less than 20 psi and the third range pilot pressure rises to within 20 psi of makeup pressure.

4.7.3.2.11.6 Control shaft operating forces. To determine compliance with 3.3.9.4, the transmission shall be operated with no load to the outputs as follows:

a. With the range selector in neutral and the input speed at 775 to 825 rpm, the torque required to rotate the steer shaft for left and right steer inputs shall not be greater than that specified in 3.3.9.4a.

b. With the input speed at 775 to 825 rpm and the throttle linkages disconnected from the transmission, the torque required to rotate the throttle input shall not be greater than that specified in 3.3.9.4.b.

4.7.3.2.11.7 Cut-in speed. To determine compliance with 3.3.9.5, the transmission shall be operated with separate engine and transmission throttle input control linkages. With the range selector in forward and no loads on the dynamometers, apply engine throttle to increase the engine speed slowly with the transmission throttle remaining at idle. Output shaft rotation shall not occur below the engine speed specified in 3.3.9.5. Return the engine throttle to idle; outputs shall stop. Repeat sequence with range selector in reverse.

4.7.3.2.11.8 Rated forward ratio. Conformance to 3.3.9.6 shall be demonstrated with the range selector in forward and no loads on the dynamometers; increase the throttle until an input speed of 2600-2625 rpm is obtained. Output speed shall be a minimum of the input speed multiplied by the rated ratio as specified by 3.3.9.6.

4.7.3.2.11.9 Rated reverse ratio. Conformance to 3.3.9.7 shall be demonstrated with the range selector in reverse and no loads on the dynamometers; increase the throttle until an input speed of 2600-2625 rpm is obtained. Output speed shall be a minimum of the input speed multiplied by the rated ratio as specified by 3.3.9.7.

4.7.3.2.12 Transmission friction. To determine compliance with 3.3.10, the transmission shall be operated in accordance with the criteria specified in Table V with the dynamometers off.

4.7.3.2.13 Cooling point heat rejection. To determine compliance with 3.3.11, the transmission shall be operated as follows:

a. Operate the transmission with separate engine and transmission throttle controls. While at idle, place the range selector in low range hold.

b. With wide open throttle input (2550 ±50 rpm) and input power at 430 ±5 hp. stabilize conditions with a dynamometer load of 4300 ±50 ft-lb (2100 ft-lb per side minimum).

c. Reduce the flow through the oil cooler to allow the oil inlet temperature to stabilize at 260 ±2°F for a minimum of 10 minutes. Do not allow the oil temperature to increase at a rate faster than 10°F per minute.

d. When stabilized at an oil inlet temperature of 260 ±2.5°F, increase the dynamometer loads to conform with the requirements specified in 3.3.11 and adjust the throttle controls to achieve the input speed and power requirements specified in 3.3.11. Adjust the simulated PTO demand flow to achieve a minimum flow of 5.2 gpm. Operate the transmission for not less than 15 minutes at this steady state condition. Record the input and output speeds and torques and the simulated PTO flow rate.

e. Confirm that the total heat rejection is within the specified requirements using the following formula for normalized heat rejection:

Heat Rejection (HR) $= (HP_{in} - HP_{out}) \times 42.44$

Normalized HR = 430 x (Observed HR)/Observed Input HP

4.7.3.2.13.1 Post durability cooling point heat rejection. To determine compliance with 3.3.4a., the transmission shall be operated in accordance with the procedures specified in 4.7.3.2.13 using the output loading specified in 3.3.4a.

4.7.3.2.14 Maximum speed limiter. To determine compliance with 3.3.12 the transmission shall be operated as follows:

a. Operate the transmission with separate engine and transmission throttle controls. While at idle, place the range selector in low range hold.

b. With wide open throttle input (2550 ±50 rpm) and input power at 430 ±5 hp. stabilize conditions with a dynamometer load of 4300 ±50 ft-lbs (2100 ft-lbs minimum per side).

c. Reduce the flow through the oil cooler to allow the inlet oil temperature to stabilize at 260 ±2°F for 10 minutes. Do not allow the inlet oil temperature to rise at a rate faster than 10°F per minute.

d. Slowly increase dynamometer loads to achieve an output speed of 220 ±25 rpm average, adjust engine schedule as necessary to obtain 430 ±5 hp while maintaining full transmission throttle signal. Confirm input speed is within that specified by 3.3.12.

4.7.3.2.15 Torque test. To determine compliance with 3.3.13, the transmission shall be operated as follows:

a. Input controls shall be configured for separate engine and transmission throttle inputs; place the range selector in the forward position.

b. Increase the throttle input controls to obtain 2500 ±50 rpm input speed with 840 ±20 ft-lb of input torque.

c. Gradually apply even dynamometer loads to obtain 6650 ±50 ft-lb of output loading (3300 ft-lb minimum load per side).

d. Record the input and output speeds and torques, reduce dynamometer loads and return throttle signals to idle.

4.7.3.2.16 Load test. To determine compliance with 3.3.14, the transmission shall be operated as follows:

a. Input controls shall be configured for separate engine and transmission throttle inputs; place the range selector in the forward position.

b. Increase the throttle input controls to obtain 2500 ±50 rpm input speed with 840 ±20 ft-lb of input torque.

c. Adjust the dynamometer load such that the output speeds are at 2500 ±50 rpm for both left and right outputs and the load on each side are even.

d. Record the input and output speeds and torques, reduce throttle inputs to idle.

4.7.3.2.17 Slope operation. To determine compliance with 3.3.15, demonstration shall be by either method a. or b. as follows:

Method a.

The transmission shall be installed in a vehicle system (see 6.1) and the requirement specified in 3.3.15 shall be demonstrated by negotiating the specified slope conditions during operational test.

Method b.

The transmission shall be installed in a test stand and connected to a power source as specified in 4.7.3.1.2 and 4.7.3.1.3 respectively. The complete test stand arrangement shall have the capability to operate at the transmission slopes and directions as specified in 3.3.15.

With the range selector in the forward position, the transmission shall be operated at the input and output loading conditions experienced during vehicle operations at these slopes and directions.

4.7.4 Environmental testing.

4.7.4.1 Cold storage. To determine compliance with 3.4.1.1, the transmission shall be installed in an approved cold test facility. The transmission shall be coupled to an approved power source external to the cold test chamber. The ambient temperature conditions within the cold test chamber shall be controlled as follows:

a. The ambient temperature shall be lowered from room temperature to the specified cold soak temperature such that the difference between the air temperature (within the cold chamber), and the transmission hardware temperature will not exceed 80°F.

b. At no time during the cold testing procedure shall the ambient temperature within the cold test chamber drop below -75°F.

c. With the transmission temperature stabilized at the specified requirement, the transmission shall be exposed to a cold soak (see 6.5.1) for not less than 8 hours.

4.7.4.2 Cold cranking torque. To determine compliance with 3.4.1.2, the transmission shall be installed in an approved cold test chamber and stabilized at the specified ambient temperature in accordance with 4.7.4.1. The transmission input shall be connected to an approved power source by means of a torque shaft meter. The power source shall be equipped with suitable means to effect engine cranking speed of not less than 80 rpm over a torque range of zero to 2000 ft-lb. The following shall apply:

a. Allow the transmission to stabilize at an ambient temperature of -60° ±2.5°F, but not less than 10° F above the stable pour point of the oil for a minimum of 8 hours.

b. With Range selector in Neutral, initiate starter motor cranking. After 3 seconds of cranking, record cranking speed of the engine in rpm and the cranking torque in ft-lb.

4.7.4.3 Proof of function. To determine compliance with 3.4.1.3, the transmission shall be installed in approved cold test chamber and connected to an approved power source. The transmission shall be stabilized at an ambient temperature of -25 ±2.5°F for a minimum of 8 hours, in accordance with the ambient temperature control procedures specified in 4.7.4.1. A flashing electronic assembly (EA) status light, for temperature out of range, is allowable for transmission temperatures below -20°F. This non-critical fault condition shall clear as the transmission temperature rises above -20°F during testing. Test equipment must be able to determine EA fault Code 13, temperature out of range. No other fault codes shall be allowed during this test. Following temperature stabilization, the transmission shall be tested as follows:

a. The range selector and steer inputs as specified in Table IV and the input speed at 1200 ±100 rpm, record the direction and speed of the output shaft rotations.

b. With the range selector in forward, rotate the throttle input to achieve an input speed of not less than 2100 rpm. Observe the output shaft speeds and function of all ranges. Engine acceleration and deceleration rates shall not exceed 260 rpm per second.

4.7.4.4 Steam and waterjet cleaning. To determine compliance with 3.4.2, all transmission interface openings shall be sealed and the transmission shall be steam cleaned using high pressure steam. After steam cleaning, the transmission shall be waterjet washed. The following methods of steam and waterjet wash shall be used:

a. Steam shall be provided at a rate of 70 to 90 gallons per hour at a temperature of 300°F with a pressure of 100 to 110 psig. The steam jet shall be applied perpendicular to the surface being cleaned at a distance of 9 to 12 inches and a rate of 1 square foot per minute until all external surfaces have been exposed.

b. A waterjet of normal cold tap temperature at 100 to 110 psi and a rate of 300 gallons per hour shall be applied at a rate of 1 square foot per minute coverage from a distance of 3 to 5 feet until all external surfaces have been exposed.

c. Following a minimum of 10 minutes of transmission operation, an oil sample shall be extracted and analyzed for increase in water content of the oil. No damage may be sustained by the transmission assembly either internally or externally by the steam and waterjets. An increase in water content of the oil or damage to the transmission shall constitute a failure as specified in 3.3.1.

4.7.5 Electromagnetic radiation. The transmission shall be tested in accordance with MIL-STD-461 to verify compliance with 3.5.

4.7.6 Reliability. To determine compliance with 3.6, the specified point estimate value shall be demonstrated during testing. The testing shall be accomplished by installing and operating the transmission in an approved facility in compliance with the duty cycle composition in accordance with 3.6.2. The facilities will include either actual or load simulated (dynamometer) vehicle operation which shall be as specified by the acquisition document (see 6.2). The point estimate shall be computed by dividing the total cumulative test miles or equivalent hours of all test by the total cumulative chargeable failures (see 3.6.1) experienced by the transmission test sample population.

4.7.7 Maintainability. To determine compliance with 3.,7.1, the maintainability of the transmission shall be verified during the reliability demonstration specified in 4.7.6 under controlled test conditions when active maintenance time (man hours) is accurately recorded.

4.7.8 Characteristics.

4.7.8.1 Interface. To determine compliance with 3.2.7.1, all transmission interface dimensions and features defined by Drawing 12446504 shall be inspected by functional gages and/or coordinate measurement equipment.

4.7.8.2 Installation control. To determine compliance with 3.2.7.2, the transmission and/or major subassembly components shall be inspected by functional gages and/or coordinate measurement equipment as follows:

a. Transmission envelope dimensions which are directly established by the outline dimensions of component parts or subassemblies shall be inspected to assure conformance to Drawing 12446504. These dimensions may be inspected at the appropriate component part level prior to assembly.

b. Transmission envelope dimensions which are subject to variation due to shim selection or gasketed interfacing shall be inspected after final assembly to assure conformance to Drawing 12446504.

c. Reference and toleranced dimensions defining the location/position shall be inspected to assure conformance to Drawing 12446504. These dimensions may be inspected at the appropriate component part level prior to final assembly.

d. Referenced and toleranced dimensions which define access/removal clearance requirements for in vehicle servicing and maintenance actions shall be inspected after final assembly to assure conformance to Drawing 12446504.

4.8 Inspection of packaging. The preservation, packaging and marking shall be inspected to determine compliance with 5.1 and 5.2 (see 6.2).

5. PACKAGING

5.1 Preservation and packaging. The transmission shall be cleaned and protected in accordance with Drawing 12380484, and preserved and packaged in accordance with MIL-STD-2073/1, or as directed by the contract or purchase order (see 6.2).

5.2 Marking. Packaging and shipping containers shall be marked in accordance with the requirements of MIL-STD-129. Marking shall include serial numbers and other markings required by the contract or purchase order.

6. NOTES

6.1 Intended use. The transmission manufactured in accordance with this

specification is intended for use in the M2 and M3 Bradley and Multiple Launch Rocket System Carrier (MLRS) family of fighting vehicles (FVS).

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.

b. Drawing titles, numbers, revision letters and dates.

c . If first article inspection is required (see 3.1).

d If durability shall be other than as specified (see 3.3.4).

e. If inlet oil temperature shall be other than as specified (see 3.3).

f. If demonstration of cold environmental conditions shall be other than as specified (see 3.4.1).

g. If product marking shall be other than as specified (see 3.8).

h. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1, 2.1.2 and 2.2).

i. If input power capability shall be other than 600 hp (see 3.3.2.1, 3.3.9.1.1 and 4.7.3.1.3).

j. If demonstration of reliability shall be other than as specified during first article inspections (see 3.6 and 4.7.6).

k. If demonstration of slope operation shall be other than as specified (see 3.3.15).

1. Level of preservation and package marking (see 5.1 and 5.2).

The procuring agency, via letter of notification to the contractor, may allow the performance of control tests of this document to constitute compliance with the control test requirements of both the higher level transmission assembly (Drawing 12446500) and its subassembly Interface Assembly (Drawing 12446586 and specification 12446503) product specifications. Application of the allowance is permissible only when the contractor is in continuous production of both assemblies at the same manufacturing facility, unless otherwise noted.

Transmission assemblies and interface assemblies will be traceable by lot. to the performance of these control tests. The respective lots will capture all quantities of each product built at the facility during the cycle time of the control test sample.

6.3 First article. When first article inspection is required, the contracting officer should provide specific guidance to officers whether the item(s) should be a preproduction sample, a first article sample, a first production item, or a standard production item from the contractor's current inventory, and the number of items to be tested as specified in 4.4. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired to be tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.4 Subject term (key word) listing.

Controller, digital
Controller, electromechanical, digital
Controller, transmission, electronic
Transmission electronic controller

6.5 Definitions.

6.5.1 Cold soak. The term "cold soak" shall be defined as maintaining the temperature of the transmission and its working fluids to within 5°F of the specified temperature.

6.5.2 Seep. Any evidence of fluid beyond a seal or split line that does not result in formation of a droplet.

6.5.3 Leak. Any evidence of fluid beyond a seal or split line that results in the formation of a droplet.

6.5.4 Drip. Any evidence of fluid beyond a seal or split line where droplets form and fall.

6.5.5 Wash. The term "wash" shall be defined as spraying the transmission with high pressure steam to clean oil and grease from the transmission to allow visible inspection for leaks.

6.5.6 Steer input signal. A clockwise rotation (facing top of the controller) of the transmission steer input shaft is a command signal for a right steer.

6.5.7 Output shaft rotation direction. A clockwise rotation of the right-hand output shaft (facing the right-hand output) is denoted as RH forward speed. A counterclockwise rotation of the left-hand output shaft (facing the left-hand output) is denoted as LH forward speed.

6.5.8 Direct interface dimensions. Those interface characteristics which control the fit position and alignment of hardware that is directly coupled to the transmission. These dimensions are designated on Drawing (12446504).

6.5.9 Transmission orientation. The terms "right" and "left" are defined as follows:

a. The "right" side of the transmission is the side on the viewer's right as he faces the input flange with top controller (IA) positioned up, oil pan cover down.

b. The "left" side of the transmission is the side on the viewers left as he faces the input flange with top controller (IA) positioned up, oil pan cover down.

c. These definitions are established relative to the transmission only and are not relative to the vehicle orientation.

6.6 Changes from previous issue. For changes from previous issues, consult the record of revisions as listed on Page ii. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content rather than relationship to the last previous issue.

APPENDIX A

101. TEC TRANSMISSION ELECTROMAGNETIC RADIATION REQUIREMENTS.

101.1 Scope. This procedure shall be done in accordance with MIL-STD-461C, tailored to best represent the System as presently fielded based on data provided by FNC, Hughes and PMO. This appendix is a mandatory part of the specification. The information contained herein shall be considered necessary for compliance.

101.2 Applicable documents.

MIL-STD-461C Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference

101.3 EMI test limits. EMI test limits of MIL-STD-461 are tailored for the transmission as follows:

101.3.1 Radiated emissions.

101.3.1.1 RE01 limits shall be in accordance with MIL-STD-461C, CLASS A3 as shown in figure 10-1 herein.

101.3.1.2 RE02 narrowband emissions shall be as modified in figure 10-2.

101.3.1.3 RE02 broadband emissions shall be as modified in figure 10-3.

101.3.2 Radiated susceptibility.

101.3.2.1 RS03 limits shall be as modified in Table 10-I.

TABLE 10-I. RS03 modified.

EMRH TEST ENVIRONMENT

Frequency	Average Field (V/M)		Peak Fields (V/M)	
	Vertical	Horizontal	Vertical	Horizontal
14 kHz – 100 kHz	1	1	-	-
100 kHz – 10 mHz	100	10	200	20
10 mHz – 100 mHz	100	100	200	20
100 mHz – 12.4 gHz	200	200	20,000	20,000

EMRO TEST ENVIRONMENT
COMMUNICATION EQUIPMENT

Frequency	Prelaunch Field (V/M)			Flight Fields (V/M)		
	CW	AM	FM	CW	AM	FM
100 kHz – 2 mHz	25	25	-	25	25	-
2 mHz – 20 mHz	50	50	-	50	50	-
20 mHz – 100 mHz	50	50	50	50	50	50
100 mHz – 500 mHz	25	25	-	25	25	-
500 mHz – 1000 mHz	50	50	-	50	50	-

NOTE: Amplitude Modulation (AM) shall also include 400 and 1000 Hz.

EMRO TEST ENVIRONMENTS, RADARS

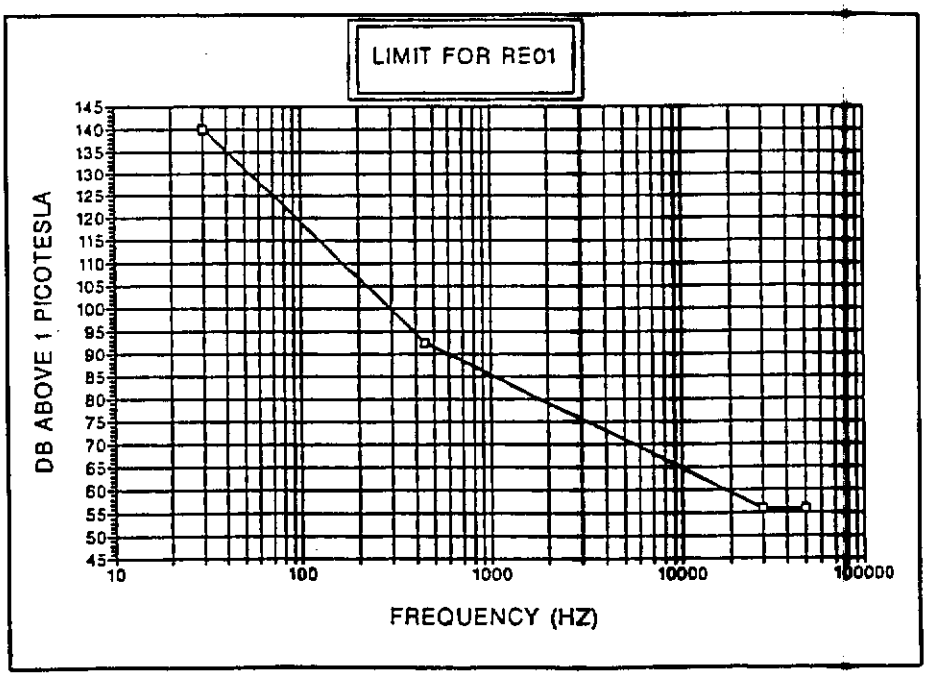
Frequency	Prelaunch Field (V/M)		Flight Fields (V/M)	
	Peak	Average (PM)	Peak	Average (PM)
400 mHz – 1200 mHz	10,000	50	10,000	50
1200 mHz – 12.4 gHz	20,000	200	20,000	300

The following exception will be taken to EMRO TEST ENVIRONMENT.

FREQUENCY	FIELD LEVEL V/M (Horizontal, Vertical)	MODULATION
400 mHz - 1.2 gHz	400	5 µs @ 1000 Hz
1.2 gHz - 2 gHz	300	5 µs @ 1000 Hz
2 gHz - 4 gHz	350	5 µs @ 1000 Hz
4 gHz - 8 gHz	450	5 µs @ 1000 Hz
8 gHz - 10 gHz	625	5 µs @ 1000 Hz
10 gHz - 11.5 gHz	550	5 µs @ 1000 Hz
11.5 gHz - 12.4 gHz	650	5 µs @ 1000 Hz

TEC EMI LIMITS FOR REO1

FREQ X AXIS	DB MicroV/M Y AXIS
30	140
450	92
30000	56
50000	56

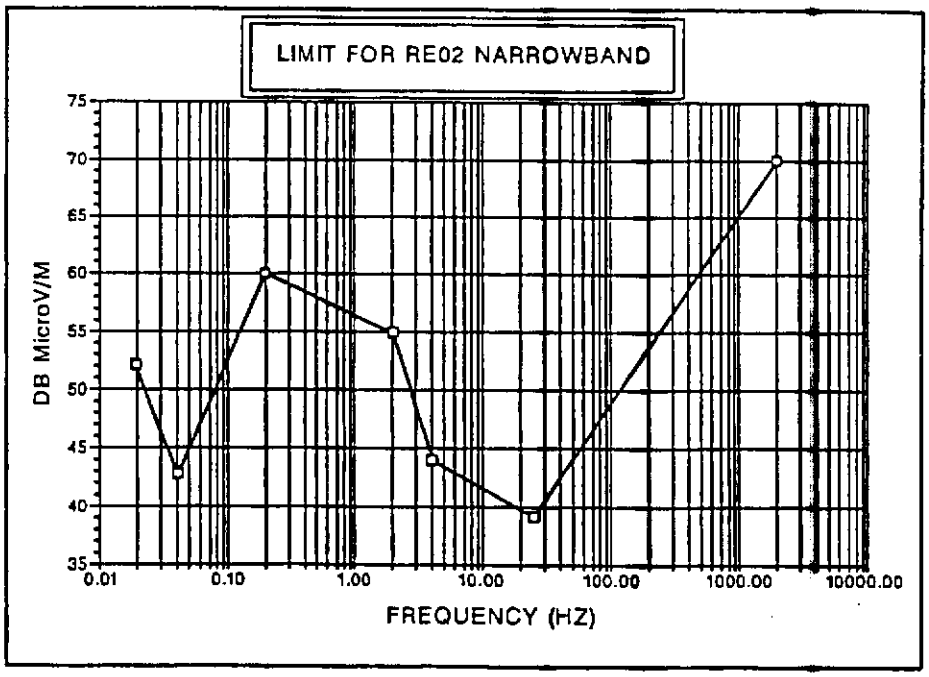


ICPS-05

Figure 10-1. Limit for RE01

TEC EMI LIMITS FOR REO2 NARROWBAND

FREQ X AXIS	DB MicroV/M Y AXIS
0.02	52
0.04	43
0.2	60
2	55
4	44
25	39
2000	70

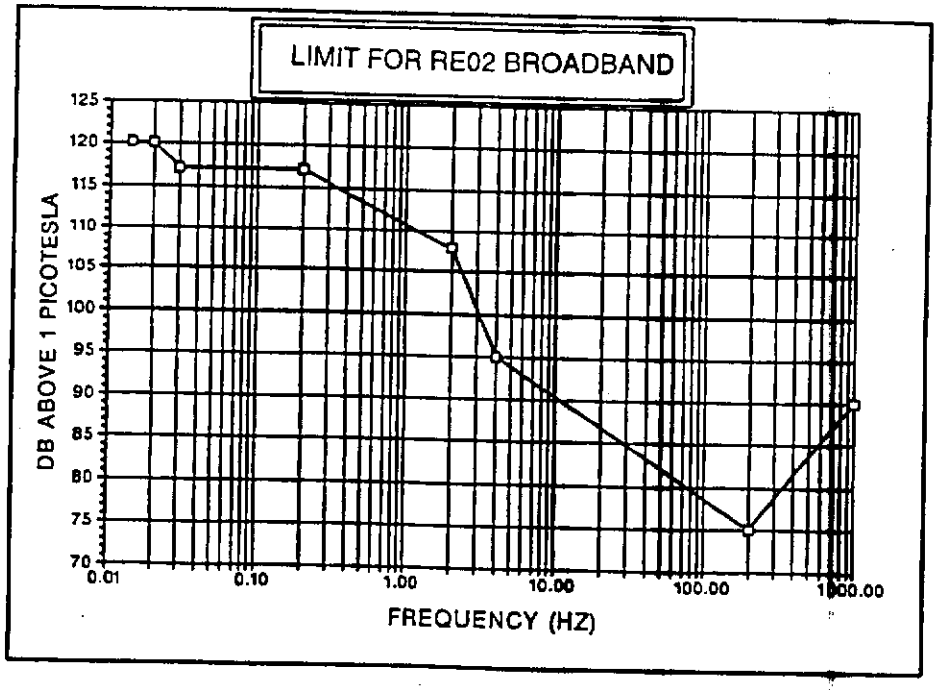


ICPS-06

Figure 10-2. Limit for RE02 narrowband emissions.

TEC EMI LIMITS FOR RE02 BROADBAND

FREQ X AXIS	DB MicroV/M Y AXIS
0.015	120
0.02	120
0.03	117
0.2	117
2	108
4	95
200	75
1000	90



ICPS-07

Figure 10.3. Limit for RE02 broadband emissions.